Arent Fox
1050 Connecticut Avenue, NW
Washington, DC 20036-5339

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Federal Communications Commission
Office of Secretary

Mitchell Lazarus
lazarusm@arentfox.com
Tel: 202/857-6466
Fax: 202/857-6395

September 10, 1996

DOCKET FILE COPY ORIGINAL

Mr. William F. Caton, Acting Secretary
Federal Communications Commission
1919 M Street, NW, Room 222
Washington, D.C. 20554

Re: Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services, CC Docket No. 92-297

Dear Mr. Caton:

On behalf of Sierra Digital Communications, Inc. ("Sierra"), I am filing the original and one copy of the attached written ex parte communication pursuant to Section 1.1206(a)(1) of the Commission's Rules.

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If there are any questions about this filing, please call me directly at the number above.

Respectfully submitted,

Mitchell Lazarus

Mitchell Lazarus

Enclosure

cc (w/encl): Office of the Secretary (2 copies)
Chairman Reed E. Hundt
Commissioner James H. Quello
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Gerald P. Vaughan

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September 10, 1996

Suzanne Toller, Esquire
Office of Commissioner Chong
Room 844
Federal Communications Commission
1919 M Street N.W.
Washington, D.C. 20554

Re: Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services, CC Docket No. 92-297

Dear Suzanne:

During our meeting in your office on September 4, you posed several questions relating to point-to-point operations in the 31 GHz band. I am pleased to attach two letters from officials of Sierra Digital Communications, Inc. ("Sierra") that respond in detail. For your convenience, I have summarized the responses here.

In what locations would an allocation of 25 MHz at each end of the 31 GHz band (50 MHz total) not suffice for point-to-point operations?

The FCC Rules provide for 25 and 50 MHz channels in the 31 GHz band.[1/] Current equipment uses the full 25 MHz for low- and moderate-speed data applications and 50 MHz for high-speed data and video.

The proposal to allocate 25 MHz at each end of the 31 GHz band for point-to-point applications would provide only one channel pair for data. Most traffic control installations (and many other applications) use more than one channel. For example, the largest Sierra-equipped traffic control systems are:

State of California (CalTrans Districts 3, 5, and 11)
Flagstaff, AZ
Honolulu, HI

[1/] 47 C.F.R. § 101.101(c).

Long Beach, CA
Palm Springs, CA
Phoenix, AZ
San Diego, CA
Topeka, KS
Victorville, CA
State of Washington

As Sierra explained in its pleadings, 31 GHz applications are undergoing rapid growth. Large installations presently pending include:

Arlington, VA
Grand Pierce, TX
Harris County, TX
State of Hawaii
LaHabra, CA
Las Vegas, NV
State of Nevada
State of New York
North Las Vegas, NV
Palm Springs, CA (extension)
San Diego, CA (extension)
Sparks/Reno, NV
State of Texas (District 2)

None of these systems can operate in only one channel pair (50 MHz total).

Current LAN and one-way video applications require 50 MHz of contiguous spectrum, and so could not function at all in two distinct 25 MHz channels. Even if the band were configured to make the channels contiguous, there would still be enough capacity for only a single video channel. Installations in Las Vegas, NV, and throughout the state of California, among others, presently use multiple video channels, and so could not operate within 50 MHz.

How much spectrum is required to meet actual needs at the above locations?

In a typical traffic control application, traffic lights (and their associated radio units) lie in a straight line down a highway or boulevard. Each receive antenna "sees" not only the next transmitter down, but also several transmitters beyond that one, so that three or four distinct frequency pairs are usually needed to avoid interference. Moreover, a typical major intersection sends and receives data in four directions (both directions along each street), and so requires four frequency pairs for maximum reliability.

Four frequency pairs in current installations occupy 200 MHz. Sierra has concluded it is feasible to modify existing radios (and to build new ones) that accommodate four pairs within 150 MHz, at reasonable cost. Putting four pairs into less spectrum than 150 MHz is not feasible at a price accessible to point-to-point customers. (See next response.) That is part of Sierra's basis for proposing a 150/150 MHz split between point-to-point and LMDS.

What are the cost implications of manufacturing 31 GHz equipment capable of greater spectrum efficiency (to a nominal 1 bit/Hertz)?

There are two approaches to improving spectrum efficiency for data transmission in 31 GHz equipment.

The first method is to improve frequency stability. The FCC rules permit ± 0.03% tolerance on all frequencies above 19.7 GHz,[2/] and Sierra takes advantage of this tolerance to minimize equipment costs. Significant improvement in stability would require redesign and added complexity in both the transmitter and the first local oscillator in the receiver. Together these modifications would roughly triple the cost of the radio from $4,000 to about $11,500, and would also add to the costs of other components of the overall system. Sold in sufficient quantities, the price of the improved radio alone might be as low as about $8,500 -- still more than double the current cost, and well out of reach of most public safety agencies.

The second method is to change modulation technique, but that is not effective unless the frequency stability is also improved, as above. For low- and moderate-speed data transmission, this adds a few hundred dollars per unit (after the costs of improved frequency stability), but the engineering costs are very significant, ranging from about $60,000 for modest improvements up to about $200,000-300,000 in the 1 bit/Hertz range. Bringing LAN systems up to 1 bit/Hertz would, in addition, add about 40% to the cost of each radio. The new equipment would be incompatible with that presently in use, requiring the simultaneous replacement of entire systems. Traffic customers, moreover, would face the added and unpredictable expense of modifying system software for the traffic control microprocessors. That expense is likely to far overshadow equipment costs. Many city managers will not risk modifying software at any price.

[2/] 47 C.F.R. § 101.107(a).

As to video transmission, the improvements in frequency stability discussed above would permit carrying video in about 17-18 MHz. Squeezing video into a channel smaller than 17 MHz would cost about $10,000 per channel for compression equipment, far beyond the means of current customers.

Conclusion

More than 70% of 31 GHz point-to-point users are schools and hospitals linking multi-building LANs, and public safety agencies, including traffic control. Today such users must attempt to serve the public interest with very limited financial resources. The economy of equipment is a critical factor to these customers. For the reasons shown above, the use of economical equipment requires a full 150 MHz of spectrum.

Please call if you have any questions about this information.

Sincerely,

Mitchell Lazarus

Mitchell Lazarus

cc (by hand delivery):
Office of the Secretary (2 copies)
Chairman Reed E. Hundt
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Rudolfo M. Baca
John Nakahata
David R. Siddall
Michele Farquhar
Rosalind Allen
Jennifer Warren
Robert James
Karen Brinkmann
Gerald P. Vaughan

cc (by fax):

Counsel for CellularVision USA, Inc.
Douglas G. Lockie, Endgate Corporation
Douglas A. Gray, Hewlett-Packard Company
Counsel for Texas Instruments, Inc.
Hal Tenney, Sierra Digital Communications, Inc.

SIERRA DIGITAL
COMMUNICATIONS

September 6, 1996

Mr. Mitchell Lazarus
Arent Fox Kintner Plotkin & Kahn
1050 Connecticut Avenue, N.W.
Washington, D.C. 20036

Re: Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services, CC Docket No. 92-297

Dear Mitchell:

The following is in response to questions you posed to us on September 4th.

> The first question is: *Where are the locations where Sierra has installations that an allocation of 25 MHz at each end of the 31 GHz band (total of 50 MHz) would not be sufficient to meet the needs of the network..*

Sierra's narrowband 31 GHz radios (the type used for traffic signal interconnection) operate in allocated 25 MHz channels. Each channel is capable of carrying data rates up to the equivalent of 4T1s. There are currently Twelve (12) of those channels in the 300 MHz 31 GHz band divided into Six (6) frequency pairs . . . one half of each pair for transmit and the other half of the pair for receive. If Sierra were restricted to bandwidth segments of 25 MHz at each end of the 31 GHz band, only a single frequency pair would be available . . . one half of the pair at the high end and the other half of the pair at the low end.

With only a single frequency pair, Sierra would not be able to install more than one or two radio links in the same vicinity without creating the potential for interference. With that restriction, any of Sierra's current traffic control networks with more than Two (2) radio links would not be able to operate without the real potential for significant link to link interference. In a given network, the links are normally aligned in series along a boulevard or highway.

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The Ten (10) largest traffic control networks using Sierra radio links are installed in the following metropolitan and high traffic areas:

✓ California, State of	Caltrans Districts 3, 5, & 11
✓ Flagstaff	Arizona
✓ Honolulu	Hawaii
✓ Long Beach	California
✓ Palm Springs	California
✓ Phoenix	Arizona
✓ San Diego	California
✓ Topeka	Kansas
✓ Victorville	California
✓ Washington, State of	

In addition, there are a number of large installations pending. These include:

✓ Arlington	Virginia
✓ Grand Pieree	Texas
✓ Harris County	Texas
✓ Hawaii, State of	
✓ LaHabra	California
✓ Las Vegas	Nevada
✓ Nevada, State of	
✓ New York, State of	
✓ North Las Vegas	Nevada
✓ Palm Springs (expansion)	California
✓ San Diego (expansion)	California
✓ Sparks/Reno	Nevada
✓ Texas, State of	District 2

It is important to note that all of these existing and pending networks require in excess of 50 MHz of bandwidth in order to function.

There are a growing number of installations where broadband video radios are being installed to visually monitor traffic flow at hot spots along Freeways and Expressways. Video radios operate within the assigned broadband frequency pairs in the 31 GHz band. Each broadband channel is 50 MHz wide, allowing Three (3) broadband frequency pairs in the 300 MHz wide 31 GHz band. An allocation of 25 MHz at each end of the 31 GHz band would, therefore, not permit even a single broadband frequency pair, thereby eliminating this type of service to the traffic control market and other agencies within the public safety industry.

Current large installations of video radios exist in:

Las Vegas, NV and throughout the State of California

The second question is: *At the above locations, how much spectrum does Sierra need in order to meet the needs of those networks.*

Additional spectrum, beyond a total of 50 MHz (25 MHz at each end of the 31 GHz band) is required to allow proper frequency coordination to prevent individual radio links in the same location from interfering with each other. An example is the radio interconnection equipment in a four way intersection may need to send and receive information in Four (4) different directions (each of the four streets into the intersection). This indicates a need for at least Four (4) separate and distinct frequency pairs. Another example is a string of radio links interconnecting signal lights along a boulevard which have the potential of transmitting to, or receiving from, radio terminals that are not within their link. In this case, at least Four (4) frequency pairs are required to effect proper frequency planning in order to prevent this type of interference.

The answer to the question is, therefor, that Sierra needs at least Four (4) frequency pairs in order to meet the system needs of even moderate-sized traffic network installations. With 75 MHz at each end of the 31 GHz band Sierra would be able to provide Four (4) narrowband pairs and Two (2) broadband pairs. This is obviously more restrictive than being able to operate in the full 300 MHz but it is a workable solution.

In order to fit four (4) narrowband pairs into the two 75 MHz segments, Sierra would need to modify their radios to make them more spectrum efficient. Sierra would need to operate within channel spacings of 18.75 MHz. Similarly, they would need to operate the Two (2) broadband frequency pairs within channel spacings of 37.5 MHz. Sierra would accomplish this by modifying several of the radio operating parameters. The stability of the radios would need to be increased. The present spec is 0.03%. The maximum allowed deviation would be reduced to help stay within the reduced bandwidth. There are a number of other improvements that could be made, if necessary, to meet the new bandwidth restrictions.

The changes described above can be made with modest investments of time and resources in product development. Also, backwards compatibility would be maintained with existing radios already installed in the field. The changes needed to move existing users out of the center 150MHz portion of the 31 GHz band, if and when interference problems develop with LMDS users, can be made on a re-tuning basis as opposed to a replacement basis.

Sincerely,
Sierra Digital Communications, Inc.

Hal Tenney, President

cc: Drew Lance

SIERRA DIGITAL
COMMUNICATIONS

September 6, 1996

Mr. Mitchell Lazarus
Arent Fox Kintner Plotkin & Kahn
1050 Connecticut Avenue, N.W.
Washington, D.C. 20036

Re: Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services, CC Docket No. 92-297

Dear Mitchell:

The following is in response to a question you posed to me on September 4th:

> *What is the cost of designing and manufacturing a more spectrum efficient radio, for example one that would meet a one bit per Hertz requirement?*

GENERAL

The cost for a more spectrum efficient radio for data transmission can be divided into two parts, that of a modulation technique that is more efficient than straight FM or FSK and that of achieving a frequency stability of the transmitter and the local oscillator that minimize the bandwidth for frequency drift and guard band for local oscillator capture range. For low data rate FSK or audio analog systems the primary improvement will be by increased frequency stability. At higher data rate FSK and video transmission the bandwidth efficiency is almost equally distributed between the information transmitted and the frequency drift.

There are several types of data transmission used in the present traffic radios. Some traffic systems use nothing more than a simple equivalent to a four wire twisted pair. In many cases the radios are placed between runs of twisted wire. These radios are in essence the equivalent to a simple FM radio but have much higher deviation. Another series of traffic radios offer the equivalent of a single RS232 modem. These radios use a subcarrier at 2mHz. Another series of traffic radios offer four independent RS232 channels and use four subcarriers the highest of which is at 4 mHz. In addition to data transmission systems to monitor and coordinate traffic control systems the cities are now

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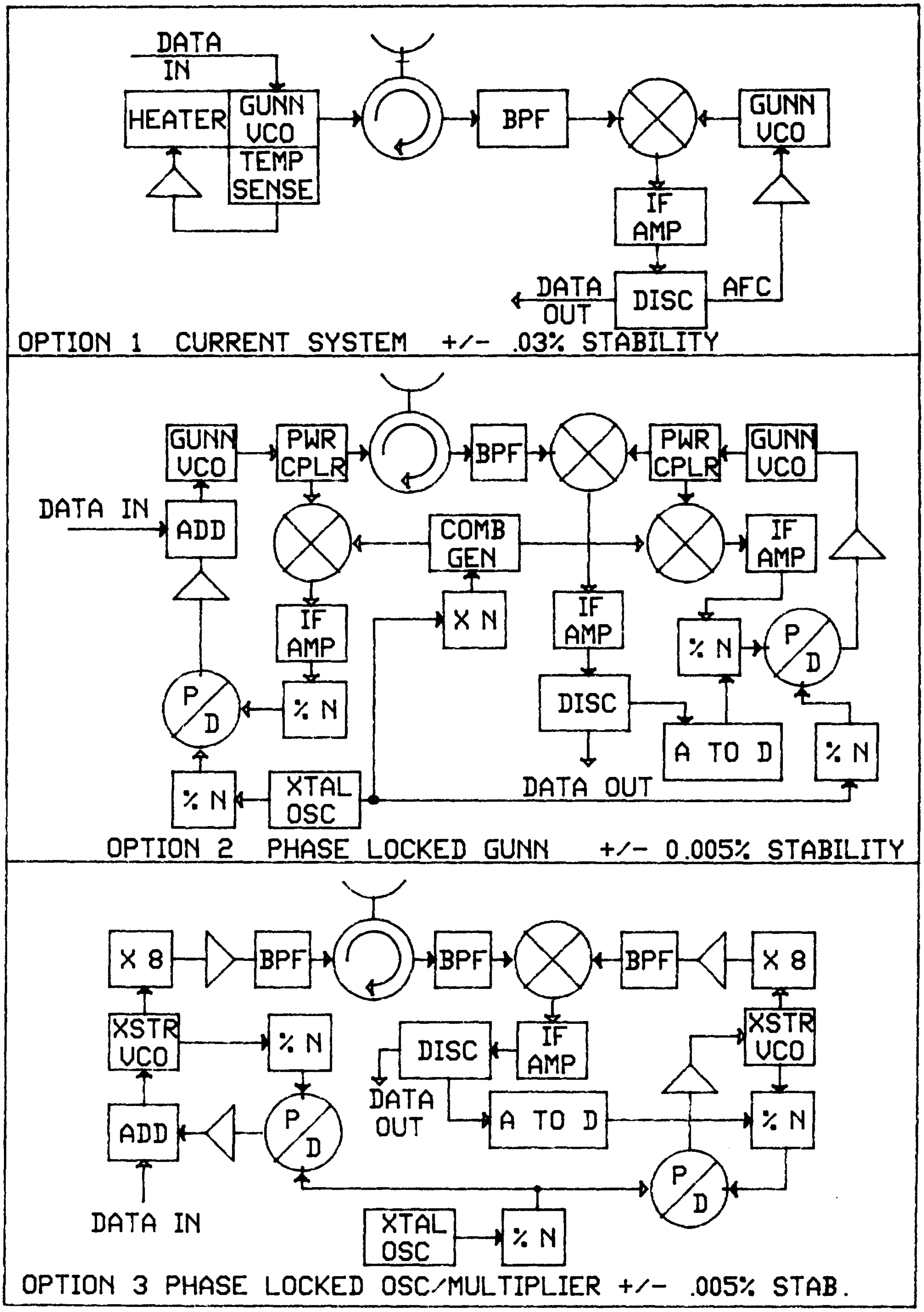
using both Video for surveillance and T1 for higher data rates. At present the highest data rate requirement is for LAN networks which require 10 mBit transmission with significant frequency components up to 12 mHz. The LAN networks are primarily used by hospitals and schools for computer hookup between buildings. Where appropriate each type of system will be discussed with respect to more efficient use of spectrum. All systems would require a much greater frequency stability to benefit from a 1 bit/Hz data transmission capability.

FREQUENCY STABILITY

The present 31 gHz FCC specifications require a stability of +/- 0.03% . This stability requirement is also required at other millimeter frequencies and unless other requirements dictate, most radios are built to this stability. Most of the radios designed to meet this specification use mechanical (bimetal etc.), or electrical compensation of the transmit Gunn diode oscillator. In some cases , temperature control is also used. Even with a combination of all of the above techniques, the best stability that can be consistently produced is about +/- 0.015% . A reasonable goal would be a stability of +/- 0.02%..

To achieve better stability, the transmitter frequency must be referenced to or generated by a crystal oscillator or equivalent. Ordinary crystal oscillators have a stability of +/- 0.005% and TCXO's and simple oven crystal oscillators have a stability of +/- 0.001% . Note that achieving a high stability for the transmitter is only half the requirement for narrow channel spacing, the real reason for high spectrum efficiency. The 1^{st} local oscillator must also be stable to prevent locking on to and receiving adjacent channels. Figure 1/Option 1 shows the current radio designed for +/- 0.03%. Options 2 and 3 show two other radios designed for crystal type stability. The complexity of the high stability systems is at least a factor of two greater than the current system. The optional approaches shown are not the only way to get stability but are representative of existing systems. These systems have different advantages. The locked Gunn diode will have better phase noise and offer better performance for video. The locked oscillator followed by a multiplier has the advantage of frequency agility. None of the radios shown will allow data transmission using phase coherent modulation and demodulation, therefore, limiting transmission to some form of FSK.

An earlier investigation of both high stability approaches was made and either approach more than doubled the cost of the millimeter wave portion of the radio. This priced the radio too high for the traffic market. Sierra does manufacture a high stability 18 gHz radio using the locked Gunn diode oscillator approach (Opt. 2). The list adder price for this option is $3750, and only the transmitter is locked to the crystal. Locking the local oscillator would double the cost of the high stability option to $7500. These high prices are in part due to the small volume requirement for this option. In quantity, the list price for locking both the transmitter and receiver local oscillator would be closer to $4500. The list price for the present Transmit/Receive Head, the millimeter wave portion of the radio, is $4000. The radios equipped with either high stability approach would not be compatible with the existing units now in service. The present radios were designed to minimize the "total" cost to the customer. Any change would probably have a ripple effect on the cost of the rest of the system. As an example, the present design uses one of the



OPTION 1 CURRENT SYSTEM +/- .03% STABILITY

OPTION 2 PHASE LOCKED GUNN +/- 0.005% STABILITY

OPTION 3 PHASE LOCKED OSC/MULTIPLIER +/- .005% STAB.

FIG. 1 2-1

signal coax cables to provide power to the Head, and an increase in coax size would be required to meet the higher DC current required for the more complex high stability radios.

DATA BANDWIDTH

There are a number of analog and digital data requirements that the 31gHz radios are designed to meet. These will be discussed in order of increasing bandwidth. In general the 31 gHz radios have been developed to simulate what the traffic customer was already using, but, with the option of increased data rates in the future. This approach allowed wireless operation without reprogramming any microprocessors or rewiring any data paths.

The simplest of these is the audio radio which was designed to be equivalent to a high quality full duplex twisted pair. These are in essence FM radios built at millimeter wave frequencies. At present the deviation is set to 4 mHz peak but could be reduced to 200 kHz peak by adjusting the deviation and changing the IF bandwidth accordingly. The majority of the traffic radios in service are this type, but unfortunately there is not room in the head to install a Gunn oscillator high stability system. New high stability radios would be compatible at the audio level but could not interface at millimeter wave frequencies. There are few of these units on order and these are mostly for expansion of existing systems. Most new traffic orders are for video or multi channel radios. The cost of reducing the occupied bandwidth would add about $150 to the $4500 cost of high frequency stability. The engineering cost would be low for the analog bandwidth reduction. Digitizing the audio and then transmitting the data at 1 bit /Hertz is not appropriate considering the best possible transmitter frequency stability still uses more bandwidth than the data.

The next bandwidth level is a radio designed to perform like an RS232 modem. RS232 is an asynchronous data transmission system that requires the appearance of DC transmission. To achieve this, the modulation is placed on a 2 mHz subcarrier. This requires an occupied bandwidth of at least +/- 2 mHz and if a reasonable signal to noise is desired, +/- 4 mHz. The subcarrier could be reduced in frequency but that would make the new units totally incompatible with the old units because the interface between links is at 2 mHz. A Manchester incoded system could be developed, however, such a system would potentially require some reprogramming of the microprocessors in the controllers. The problems with this are discussed later. Manchester incoded signals are not 1 bit/Hz but would be the most logical way to reduce the bandwidth required. One bit/Hz data transmission requires clock recovery and is not appropriate for asynchronous random data. The new units would be totally incompatible with the existing units. Either new approach would require a completely new interface unit and a reduction in the IF bandwidth. There are none of this type system on order and the only customers with this type of unit are now ordering multi-channel units. The engineering cost of developing a Manchester encoded system would be about $60,000. The unit price would probably not change. This type of unit would not be acceptable to the traffic industry if any software changes were required to meet a change in signal format.

The improved RS232 unit provides four channels that can be individually routed to provide master controller monitoring, slave controller monitoring, and collision detection monitoring. (Most traffic control systems have collision detection. What they mean by this is the detection of two green traffic lights on that would cause a collision of automobiles. When this occurs, the control system is disabled to a flashing red all directions.) This RS232 system uses four subcarriers the highest of which is 4 mHz. The minimum required bandwidth is at least +/- 4mHz and with decent signal to noise is +/- 8 mHz. A single data stream system could be developed for this use. It would be required to have drop and insert capability for all channels and to interface with the asynchronous RS232 data ports on the controllers. There is little doubt that the software now installed in the controller microprocessors would require modification. The data rate for a single stream system would be about 256 kbits. After development, the cost of such a system would probably be about the same as the multi subcarrier approach. Most cities have had specialized software programs written to match their specific needs. This software is installed in the microprocessor inside the controllers located at each intersection Given the cost and past troubles with software, it is doubtful the typical city traffic manager would consider any wireless system requiring software changes at any price. Because the present units interface at the subcarrier frequencies, there would be no compatibly between systems. The engineering cost of developing such a system would be between $200,000 and $300,000. The real cost of such a system would be in the potential software development cost for the traffic control microprocessors.

Sierra builds T1 and 4 T1 radios. The data for these radios is synchronous and can be formatted to 4 level FSK which would provides 1 bit/Hertz transmission. There is some cost in doing this but it is not large. The minimum bandwidths would be 1.544 mHz or 6.2 mHz. Only a few of the traffic systems use this high a data rate, however, it is expected that compressed video may become affordable and multi channel T1 will be an ideal way to transmit the compressed video data stream. The engineering cost would be less than $50,000. The unit cost would increase by about $300/link.

The next bandwidth level is that of analog video. If Carson's rule is applied to color video the required bandwidth is 24mHz. However, reasonably good video is possible with a bandwidth 17 to 18 mHz. This bandwidth also allows subcarriers as high as 8.2 mHz. Video is the fastest growing traffic radio because with subcarriers both video and controller monitoring is possible with the same radio. The only reasonable way to reduce the occupied bandwidth of video is through digital compression such as MPEG 1 or 2. At present the cost of about $10,000 per channel for compression equipment is too high for the traffic market or for any market but point multipoint, however, that may soon change. It will then be possible to transmit video with good motion response over a T1 channel. When this occurs, the demand for multi channel video capability will actually increase the need for bandwidth. The typical traffic monitoring system is eight intersections. A video camera at each intersection would require eight T1 channels. These channels would be added to other groups which would create the need for even wider bandwidths. We estimate that the data compression/de-compression cost would need to be below $2000/camera before it would become usable in the traffic industry.

The largest bandwidth requirement is generated by LAN (local area networks) data requirements. LAN data is at 10mbit with significant sidebands to 12.5 mHz. The

LAN datastreams are asynchronous and random in occurrence. Typical LAN users are schools and hospitals for inter building data networks. There is equipment available that changes the Manchester encoded LAN data to a standard bit stream. This equipment adds about 40% to the cost of a LAN radio. The data could then be formatted to meet a 1 bit/Hz requirement. The engineering cost and increased equipment cost to meet the 1 bit/Hz would be the same as for T1.

SUMMARY

The largest improvement in occupied bandwidth is achieved by improving the stability of the transmitter and local oscillator. Unless this is done there is little reason to achieve 1 bit/Hertz data transmission on all but the highest data rate systems. Bandwidth improvement on some of the traffic control systems would not be acceptable to the users because it would require software changes to their systems. Even with all acceptable bandwidth reduction in place, the future needs cannot be met by 25 or 50 mHz at the ends of the 31 gHz band and even 75 mHz will place severe restraints on projected use. If the system stability was improved to +/- 0.02% which can be done at minimal cost and reduced deviation was incorporated, band spacing required would be 30 mHz minimum for video and 18 mHz for a four channel RS232 system. If higher stability was used the band spacing could be reduced to 20 mHz for video and 10 mHz for multi channel RS232. The cost of locking to crystal oscillators to improve stability would approximately double the cost of the present traffic radios and would not be acceptable to most users.

Sincerely,
Sierra Digital Communications, Inc.

Drew Lance

Drew Lance, Chairman and CEO

cc: Hal Tenney